

NOTES ON LARVAL CESTODE PARASITES OF FISHES.

By EDWIN LINTON, Ph. D.

Professor of Biology, Washington and Jefferson College.

THE material upon which these notes are a partial report belongs to two distinct collections:

First. A collection made by myself at Woods Holl, Massachusetts.

Second. A collection belonging to the United States National Museum.

Both of these collections are large, aggregating about 600 bottles and vials. By far the larger part of the collections are entozoa of fish. A report on material representing such a wide range of species, some of the species represented by very few or by but one specimen, can not be other than unsatisfactory. It is hoped, however, that the notes here given may prove to be of some assistance to future investigators in the work of identification.

It should be remarked that the finding of a larval cestode parasite encysted in the tissues of a fish is not always proof that the fish is a true intermediate host. This goes without saying when the host of the encysted parasite is a large shark. Beneden invented the term *xenosite*—i. e., stranger—for this condition of parasitism.

List of parasites and hosts.

No.	Parasite.	Host.	Plate.	Figure.
1	<i>Ligula chilomyeteri</i>	<i>Chilomycterus geometricus</i>	I.	1
2	Cysts	<i>Sarda sarda</i>	I.	2, 3
		<i>Cynoscion regalis</i>	I.	6-13
		<i>Limanda ferruginea</i>	I.	4
3	Larval <i>Echinobothria</i>	<i>Stenotomus chrysops</i>	I.	14, 15
		<i>Paralichthys dentatus</i>	I.	5
		<i>Lophius piscatorius</i>	I.	5
4	<i>Phyllobothrium loliginis</i>	<i>Ommastrephes illecebrosus</i>	II.	1-9
5	<i>Thysanocephalum</i> , sp.	<i>Ommastrephes illecebrosus</i>	II.	10, 11
6	<i>Rhynchobothrium bulbifer</i> , Linton	<i>Alutera schoepfi</i>		
		<i>Pomatomus saltatrix</i>		
7	<i>Rhynchobothrium</i> larvae:			
	(1)	<i>Centropristes striatus</i>	II.	12
	(2)	<i>Caranx chrysos</i>	II.	13-15
	(3)	<i>Anguilla chryssypa</i>	III.	16
	(3a)	<i>Cynoscion regalis</i>	IV.	1
	(4)	<i>Microgadus tomeod</i>	III.	2
	(5)	<i>Scomberomorus regalis</i>		
	(6)	<i>Sarda sarda</i>		
	(7)	<i>Prionotus eolans</i>	III.	3-5
	(8)	<i>Menticirrhus saxatilis</i>	III.	6
	(9)	<i>Phycis tenuis</i>		

List of parasites and hosts—Continued.

No.	Parasite.	Host.	Plate.	Figure.
7	<i>Rhynchobothrium</i> larvæ—Continued.			
(10)	.....	<i>Phycis chuss</i>		
(11)	.....	<i>Macrurus bairdii</i>	III.	7, 8
(12)	.....	<i>Stenotomus chrysops</i>	III.	9-13
(13)	.....	<i>Carcharias littoralis</i>	III.	14-17
(14)	.....	<i>Pomatomus saltatrix</i>	III.	17-19
(15)	.....	<i>Paralichthys dentatus</i>		
(16)	.....	<i>Alutera schoepfii</i>		
(17)	.....	<i>Carcharias littoralis</i>		
(18)	.....	<i>Mustelus canis</i>	IV.	2
(19)	.....	<i>Cottus</i> , sp.....		
(20)	.....	<i>Cottus</i> , sp.....		
(21)	.....	<i>Cynoscion regalis</i>		
(22)	.....	<i>Paralichthys oblongus</i>		
8	<i>Rhynchobothrium heterospine</i> , Linton.....	<i>Anguilla rostrata</i>	IV.	3-8
		<i>Paralichthys dentatus</i>	IV.	9-12
		<i>Lophius piscatorius</i>		
		<i>Microgadus tomcod</i>		
		<i>Scomber scombrus</i>		
9	<i>Rhynchobothrium imparispine</i> , Linton.....	<i>Bothus maculatus</i>		
		<i>Tautoga onitis</i>		
		<i>Cetopriste striatus</i>		
		<i>Gadus callarias</i>		
		<i>Melanogrammus aeglefinus</i>		
		<i>Paralichthys dentatus</i>	IV.	13, 14
		<i>Pomatomus saltatrix</i>	V.	1-3, 7
		<i>Stenotomus chrysops</i>		
10	<i>Rhynchobothrium speciosum</i> , new species.....	<i>Tylosurus caribbeus</i>	V.	4, 5
		<i>Cynoscion regalis</i>	V.	6
		<i>Scomber scombrus</i>		
		<i>Chaetodipterus faber</i>		
		<i>Echeneis remora</i>		
11	<i>Rhynchobothrium attenuatum</i> , Rudolphi.....	<i>Xiphias gladius</i>	V.	8-11
12	<i>Otobothrium dipsacum</i> , new species.....	<i>Pomatomus saltatrix</i>	VI.	1-5
13	<i>Tetrarhynchus</i> , larvæ:			
(1)	.....	<i>Carcharinus obscurus</i>		
(2)	.....	<i>Sphyrna zygaena</i>		
(3)	.....	<i>Scomberomorus regalis</i>		
(4)	.....	<i>Chaetodipterus faber</i>	VI.	8, 9
(5)	.....	<i>Trygon centrura</i>		
(6)	.....	<i>Mustelus canis</i>	VI.	6, 7
(7)	.....	<i>Raja erinacea</i>		
(8)	.....	<i>Lophius piscatorius</i>		
(9)	.....	<i>Tetrapturus imperator</i>		
(10)	.....	<i>Pseudopleuronectes americanus</i>		
(11)	.....	<i>Stromateus triacanthus</i>	VI.	10
		<i>Paralichthys dentatus</i>	VI.	11
		<i>Cynoscion regalis</i>	VI.	12, 13
14	<i>Tetrarhynchus bisulcatus</i> , Linton.....	<i>Tetranarce occidentalis</i>	VI.	14, 15
		<i>Stenotomus chrysops</i>		
		<i>Seriola zonata</i>		
15	<i>Tetrarhynchus erinaceus</i> , Beneden.....	<i>Cynoscion regalis</i>	VII.	1-5
		<i>Pomatomus saltatrix</i>	VII.	6-8
16	<i>Tetrarhynchus elongatus</i> , Wagener.....	<i>Mola rotunda</i>	VII.	9-12
		<i>Coryphæna hippurus</i>	VIII.	2
17	<i>Tetrarhynchus bicolor</i> , Bartels.....	<i>Xiphias gladius</i>	VIII.	1
		<i>Carcharinus obscurus</i>	VIII.	5, 6
		<i>Galeocerdo tigrinus</i>	VIII.	3, 4
		<i>Pomatomus saltatrix</i>	VIII.	12
		<i>Cynoscion regalis</i>	VIII.	7, 11
		<i>Mustelus canis</i>	VIII.	9
		<i>Scomberomorus regalis</i>		
18	<i>Synbothrium filicollis</i> , Linton.....	<i>Pomolobus medioeris</i>		
		<i>Trygon centrura</i>	VIII.	10
		<i>Lobotes surinamensis</i>		
		<i>Scomberomorus cavalla</i>		
		<i>Scomberomorus maculatus</i>		
		<i>Paralichthys dentatus</i>	VIII.	8

I. LIGULA CHILOMYCTERI. (Dibothrium larva.)

(Plate I, fig. 1.)

From spleen of rabbit-fish (*Chilomycterus geometricus*) Woods Holl Massachusetts, July 21, 1887 (No. 4791, U.S.N.M.).

A specimen inclosed in a membranous cyst and coiled up irregularly

ERRATA.

In the paper "Notes on Larval Cestode Parasites of Fishes" the reader will please read for Plate I, Plate LXI; for Plate II, Plate LXII, and so on until Plate VIII, which should read Plate LXVIII.

EDITOR.



in the spleen of its host appears to be a *Ligula*. Its length, in life, was 100 mm., the breadth of the anterior fourth about 6 mm., that of the posterior three-fourths about 2 mm. When placed in sea water, constrictions formed at intervals throughout the length, and the anterior end, which before was retuse, became conical.

The alcoholic specimen is quite irregularly contracted, but at the anterior end it is smooth, regular, with conical apex. Transverse striæ begin about 2 mm. from the anterior tip. Transverse sections show the muscular layers of the body wall and the central parenchyma with the beginnings of the reproductive organs.

2. Cysts from Bonito.

(Plate I. figs. 2, 3.)

Small cysts from peritoneum of the bonito (*Sarda sarda*) Woods Holl, Massachusetts, August 5, 1889 (No. 4785, U.S.N.M.).

Dimensions of alcoholic specimens: Length of cyst, 2.5 mm.; breadth, 1.25; length of embryo, 2.25; diameter of embryo, 0.34 to 0.43; principal diameters of one of the oval bodies at larger end, 0.044 and 0.018—of another, 0.035 and 0.022.

The cysts look like *Dibothrium* cysts. The larvæ are worm-like in shape, with a thin body wall in which are both longitudinal and circular fibers. Oval and spheroidal bodies which do not yield carbon dioxide with acetic acid fill the interior of the body at the larger end and extend to near the middle of the body. These bodies give to that part of the body in which they lie a dark amber color. Elsewhere the body of the alcoholic specimen is light yellow.

Forms similar to these noticed among specimens from peritoneum of file-fish (*Alutera schapfi*) Woods Holl, Massachusetts, August 5, 1889.

3. Larval ECHENEIBOTHRIA.

(Plate I. figs. 4-15.)

Echeneibothria, LINTON, U. S. Fish Com. Rept., 1886, pp. 453, 454, pl. VI, figs. 6, 7.

1. During the months of July and August, 1889, at the Fish Commission Laboratory, Woods Holl, Massachusetts, I examined, in all, seventy-three specimens of squeteague (*Cynoscion regalis*) and in all instances found the cystic duct infested with, as a rule, enormous numbers of larvæ.

These forms have already been noticed and figured, and since I have made no special study of their structure, I simply add here a few extracts from notes made at the time of collecting.

In some specimens two small red granular patches were observed on neck, back of head. Length, when extended, as much as 7.5 mm., contracting to 1.5 mm. In one lot the length when extended was from 5 to 6 mm., the breadth varying from 0.18 to 0.36 with the amount of expansion.

A small specimen in this lot with costate bothria had no red patches

on the neck. Its dimensions, living, were: Length, 0.45 mm.; breadth, 0.08; length of bothria, 0.1; breadth of head, 0.12.

In addition to those found infesting the cystic duct, others were found in the intestine of some of the fish examined. Of these there were two types, as in those of the cystic duct.

First type with a costa on each bothrium, the bothria long elliptical, body slender, proboscis (myzorhynchus) very extensible, cylindrical, with small round shallow mouth. Second type larger, stouter, with two distinct red blotches back of the bothria, no costae on bothria, or with only a faint indication of a costa on the anterior part, proboscis (myzorhynchus) round elliptical, extensible campanulate, often maintained in a comparatively rigid position with flaring bell-shaped or vase-shaped border widely open at the apex. When at rest, the body is invaginated and often contracts until it is oval or sometimes almost circular in outline. When this is the case, transverse wrinkles are apt to form on the posterior part of the body.

The specimens in the intestines were much smaller, as a rule, than those in the cystic duct.

They were found in myriads (No. 4789, U.S.N.M.) in a squeteague examined on August 18, 1886, in the chyle and adhering to the mucous membrane of the intestine. When extended until the body was quite filiform, they were as much as 2.1 mm. in length; when contracted and the head involuted, they became as short as 0.35 mm. and nearly circular in outline. Posterior edges of bothria free.

Measurements of three specimens were made with the following results, given in millimeters: First specimen, length, 0.45, breadth, 0.28; second specimen, length, 0.84, breadth, 0.17; third specimen, length, 1.05, breadth, 0.12. When these specimens are compared with respect to their superficial areas, it will be seen that they may be represented by the numbers 126, 142, and 116 respectively. Indeed dimensions corresponding to those of the first and third specimens might have been obtained without difficulty from a single living and actively contracting specimen.

Length of bothria about 0.14 mm.; breadth, 0.07 to 0.1.

Body with many highly retractile oval masses.

The primary host, or hosts, of these larvæ will doubtless be found among the various species of crabs which inhabit the feeding grounds of the squeteague and flounder. Forms resembling them have been figured by Beneden from *Carcinus* and *Pagurus* (Les Vers Cestoides, Plate I, figures 10-14), as well as from various species of fish. Wagner (Entwicklung der Cestoden, Plate 9, fig. 10 etc.) also figures forms which bear a general resemblance. The latter, however, are all from piscine hosts.

2. Larvæ from intestine of sand-dab (*Limanda ferruginea*) (No. 4814, U.S.N.M.), Woods Holl, Massachusetts, September 6, 1887.

Alcoholic specimens 2 to 2.5 mm. in length. These agree closely with some of Beneden's figures of scoleces from *Rhombus* (Cestodes, Plate I).

3. In a vial containing a cyst of a *Rhynchobothria unus* from the peritoneum of the scup (*Stenotomus chrysops*), Woods Holl, Massachusetts, July 23, 1887.

I find specimens of larval *Tetrabothria* identical with those from cystic duct of *Cynoscion regalis*. Length, 0.7 mm.; breadth, 0.3. mm.

My note made at the time of collecting is: "No. 165, July 23, 1887. Examined about a dozen specimens of *Stenotomus chrysops* found only a few cysts and embryo Cestodes." The latter may refer to the specimens here described.

4. I have found a parasite, which agrees exactly with those from the cystic duct of the Squeteague, in the common flounder (*Paralichthys dentatus*), at Woods Holl, Massachusetts, on three different occasions, namely, August, 1884, July 16 and 23, 1887 (No. 4788 U.S.N.M.).

Among the flounders examined July 16, 1887, was one whose cystic duct was infested with these parasites in the same manner as that of the Squeteague.

One specimen in this lot was noticed in which there was what appeared to be the beginning of a bifurcation of the tail (fig. 15a).

When specimens were placed in fresh water, many of them swelled up at the anterior end, becoming club-shaped or even decanter-shaped (fig. 14). In these the epidermis soon loosened and separated from the body, or rose into wrinkles.

5. Larvæ identical with those from the intestine of the squeteague were found on three occasions in the intestine of the goose-fish (*Lophius piscatorius*), at Woods Holl, Massachusetts, July 7, 1885, August 6 and August 30, 1887, in enormous numbers (No. 4786, U.S.N.M.).

In the first and second lots the living specimens varied from 1 to 2 mm. in length. When placed in alcohol, they become conical in shape, larger end anterior, from 0.4 to 0.5 mm. in length. Head of living specimen usually about 0.24 mm. in breadth, and was capable of introversion; bothria and myzorhynchus as in specimens from squeteague. Two red spots on neck.

The specimens in the third lot varied in length from 0.8 mm. to 4.5 mm.

Bothria four, oval, with apparently two transverse costæ dividing the bothria into three loculi. Two red spots in neck, only seen when worm is viewed on its flat surface; in lateral, i. e., marginal, view only one spot is seen.

There is, as in specimens from squeteague, a protrusible papillary eminence (myzorhynchus) with an os in the apex leading into a globular proboscis, as in *Echeneibothrium variabile*. No true segments appeared on any, although on the large specimens one or more transverse lines divided the body into irregular pseudosegments.

In a specimen which was placed in fresh water the bothria contracted and were directed forward, and the head assumed a globular shape.

The four bothria with the central os then gave to the head a strong resemblance to the head of *Tenia*.

These larvæ appear to belong to the genus *Echeneibothrium*.

Although found in such great numbers and so often, especially in the Squeteague, I am not disposed to think that any of the fish in which I have found these interesting forms is either the true intermediate or the proper final host of the species.

It is likely that different species are represented among these larvæ.

4. PHYLLOBOTHRIUM LOLIGINIS.

(Plate II, figs. 1-9.)

Taenia loliginis, LEIDY, Proc. Acad. Nat. Sci. Phila., 1887, p. 24.

Tetrabothrium or *Phyllobothrium loliginis*, LEIDY, Proc. Acad. Nat. Sci. Phila., 1890, p. 418.

From stomach of squid (*Ommastrephes illecebrosus*). Collected at Woods Holl, Massachusetts. The squids were taken at Provincetown, Massachusetts (No. 4801, U.S.N.M.).

The living specimens attained a length of over 20 mm.; head and neck a delicate pink or flesh color and subtransparent; body ivory white, less transparent than head and neck, and with denser refractile granules. Bothria four, very variable, with crumpled or folded border, each with an auxiliary acetabulum, a terminal papillary eminence (myzorhynchus), with fine radiating fibers. Dimensions of one of the larger specimens in millimeters, somewhat compressed: Length, 18; breadth of head, 5; breadth of neck, 3.5.

The bothria are very extensible, sometimes elongated, at other times contracted, again spread out into a large flat disk and applied to the bottom of the dish and used in locomotion (fig. 3). The lateral vessels show plainly through the transparent walls of the head and neck and can be traced to the posterior end of the body. The body becomes wider than the neck, is flat, and tapers to a point behind.

The alcoholic specimens are corrugated and puckered.

Dimensions of one of the larger alcoholic specimens: Length, 14 mm.; diameter of head, 1.5; breadth of neck, 0.7; greatest breadth of body, 1.2.

The smallest specimens in the lot are only 1.25 mm. in length.

5. THYSANOCEPHALUM sp. (Larva).

(Plate II, figs. 10-11.)

One small specimen, 1 mm. in length, from the stomach of the squid (*Ommastrephes illecebrosus*). Collected, August 28, 1886, at Woods Holl, Massachusetts. The squids were caught at Provincetown, Massachusetts (No. 4815, U.S.N.M.).

The specimen is the young of my genus *Thysanocephalum*, and presumably of the species *T. crispum*.¹

Only the scolex present.

¹ U. S. Fish Com. Rept., 1888, pp. 543-556, pls. LXI-LXVII.

6. RHYNCHOBOTHRIMUM BULBIFER, Linton. (Larva.)

Rhynchobothrium bulbifer, LINTON, U. S. Fish Com. Rept., 1886, pp. 486-488, pl. v, figs. 17, 18; 1887, pp. 825-829, pl. xi, figs. 1 and 2.

I have met on a few occasions larval *Rhynchobothria*, some of which have been sufficiently developed to refer without doubt to this species (No. 5457, U.S.N.M.), using the hooks as the principal criterion; others have been referred with some doubt to this species.

The specimens were all collected at Woods Holl, Massachusetts, one lot from the filefish (*Alutera schoepfii*), August 12, 1885. The other lots are from the bluefish (*Pomatomus saltatrix*), one collected in August, 1884, another in July, 1887, three in July, 1889, and two in August, 1889.

One specimen from a bluefish agreed in the size and arrangement of the hooks, and in character and dimensions of bothria, neck, and contractile bulbs, with *R. bulbifer*. Others from same host, very small, too rudimentary for satisfactory identification, are probably the young of this species, while others are more probably young of *R. speciosum*.

The specimens from the filefish do not agree so well in size of contractile bulbs, being shorter, and other dimensions shorter—i. e., head and neck, 1.9 mm. in length, agree in the character of the hooks and appear to be the young of this species.

7. RHYNCHOBOTHRIMUM LARVÆ.

(Plates II, figs. 12-16; III, figs. 17-35; IV, figs. 1-2.)

I have found, on many occasions and in a great variety of hosts, encysted *Rhynchobothria*, which I have been unable to identify or can determine only doubtfully. I here record such notes as I have made, endeavoring to so group the different kinds as to make the notes of some value to others for purposes of identification.

I.

I include here larval *Rhynchobothria*, from a number of hosts, which have much in common, and probably belong to the same or to closely related species.

1. Notes of two finds of *Rhynchobothrium* larvæ in sea bass (*Centropristes striatus*) have been made. Measurements on a specimen collected at Woods Holl, Massachusetts, August, 1884: Length, 1.03 mm.; length of bothrium, 0.18; length of contractile bulbs, 0.6; breadth of head, 0.23; diameter of neck, 0.21; length of longest hooks, 0.026. The specimen was encysted in the serous coat of the intestine of its host. The proboscides were retracted and the hooks of various styles, but their arrangement could not be made out. They bear some resemblance to those of *R. longispine*, Linton.

Another from the same host and locality, collected August 6, 1886, evidently the same, has hooks which agree in length with the other, but rather sparsely distributed. The proboscides were estimated to be

0.8 mm. in length, and were 0.04 in diameter (Plate II, fig. 12). (No. 4760, U.S.N.M.)

2. Cysts from the crevalle (*Caranx chrysos*). The embryos contained in these cysts are small, but the proboscides are relatively long. Some of the dimensions are: Length of proboscis, approximate, 1.5 mm.; diameter, exclusive of hooks, 0.02; length of contractile bulbs, 0.38; diameter, 0.09; length of longest hooks observed, 0.015 (Plate II, figs. 13-15). (No. 4769, U.S.N.M.)

The contractile bulbs were slightly sinuous. The hooks bear some resemblance to those of *R. heterospine*, Linton.

3. Cysts collected at Woods Holl, Massachusetts, August 26, 1885, July 23, and September 1, 1886, and August 20, 1889, from the peritoneum of the common Eel (*Anguilla chryssypa*) (Plate II, fig. 16). (No. 4764, U.S.N.M.)

The proboscides were retracted and the arrangement of hooks was difficult to make out, but they appear to be identical with those of the specimens from *Caranx*, mentioned above. The longest hooks were about 0.011 mm. in length.

Dimensions of a living specimen somewhat compressed (Plate III, fig. 1): Length of embryo, 5 mm.; length of bothrium, 0.7; breadth of bothrium, 0.63; diameter of neck, narrowest part, 0.35; length of proboscis, estimated on retracted organ, 1.4; length of contractile bulbs, 0.42; diameter of contractile bulbs, 0.07 (No. 4774, U.S.N.M.).

3a. Figure 1, Plate IV, is a sketch of a cyst from the stomach wall of *Cynoscion regalis*, Woods Holl, Massachusetts, September, 1884.

The sketch represents the cyst compressed so as to show the blastocyst and embryo. This appears to be identical with the specimens from *Caranx* and *Anguilla*. (No. 4826, U.S.N.M.)

4. Cysts from mucous membrane of the tomcod (*Microgadus tomcod*), Woods Holl, Massachusetts, July 23, 1886. These agree very closely with the specimen described above, especially with those from *Anguilla chryssypa*. The cysts were elongate-pyriform, with the embryo coiled up in the larger end (Plate III, fig. 2). The elongated neck-like part of the cyst was dull yellowish; the embryo ivory white surrounded by the translucent white blastocyst. The latter when removed was also pyriform-elongate, or rather gourd-shaped, with the embryo in the larger end (No. 4832, U.S.N.M.).

5. Cysts from the cero (*Scomberomorus regalis*), Woods Holl, Massachusetts, July 30, 1889, peritoneum, associated with larvae of tetra-rhynchus (Cat. No. 5475, U.S.N.M.). Details of hooks could not be made out; general habit of larvae like those described above. Length of cysts, 2.8 mm.

6. Larger cysts from same host, same locality, August 13, 28, 1889, peritoneum. In first lot the proboscides were retracted, approximately, 3 mm. in length; length of longest hooks observed was 0.02. Second lot, cyst oblong, 3.5 mm. long and 1.25 broad; embryo about 5 in length;

bothria 0.56 long and 0.45 broad; longest spines nearly 0.03 in length. Bothria converging in front, strongly divergent behind.

6a. Small cysts between submucous and muscular coats of stomach of the bonito (*Sarda sarda*) (Cat. No. 5458, U.S.N.M.), Woods Holl, Massachusetts, August 28, 1889. Length of embryo 0.38, of bothria 0.23, and of largest hooks 0.01 mm.

Alcoholic specimens with yellowish blastocysts, the embryo a deeper yellow; parenchyma of blastocyst coarsely granular.

7. Cysts from peritoneum of the sea robin (*Prionotus evolans*), Woods Holl, Massachusetts, July 21, 1887. The cysts are, in alcohol, small oval: Length, 1.6 mm.; breadth, 0.75; length of embryo, about 1 mm. Proboscides of embryos retracted and arrangement of hooks not evident, but bears some resemblance to *R. longispine*. Length of longest hooks about 0.02 mm. (Plate III, figs. 3, 4, 5). (No. 4757, U.S.N.M.)

II.

The larvæ enumerated in this section belong to the same or to closely related species.

8. Cysts from peritoneum of the whiting (*Menticirrhus saxatilis*), belonging to the United States National Museum Collection; but all collected at Woods Holl, Massachusetts, by Vinal N. Edwards (Plate III, fig. 6). (No. 4754, U.S.N.M.)

These were collected as follows: Nov. 10, 1886; Nov. 12, 1886; and Nov. 16, 1886.

The blastocysts, in alcoholic specimens, are nearly all dark brown, especially toward posterior end; the anterior end, which contains the coiled-up embryo, is lighter colored. Length of blastocysts, in most cases, 4 to 5 mm.; a few are longer and several shorter. Length of embryo 4 mm., neck tubular, bothria two, broadly elliptical, distinctly emarginate and somewhat bilocular, widely divergent posteriorly. Other dimensions: Length of contractile bulbs, 1.5 mm.; diameter of same, 0.25; length of bothrium, 0.8; diameter of neck, 0.68; proboscis probably nearly three times the length of the bothria, with spiral sheaths; hooks of various sizes—longest 0.06, shortest about 0.005. Calcareous bodies numerous and large, as much as 0.05 in length and 0.025 in breadth, with concentric structure, showing rather smaller in neck and head than behind contractile bulbs.

The proboscides were retracted, and it was not possible to make out the arrangement of the hooks. Two or four rows of large hooks flanked by slender hooks, with minute hooks on opposite side, appear to be the plan. It will be seen that this form bears a close resemblance to *R. imparispine*, but large hooks not so strongly curved as in that species.

9. Cysts from peritoneum of *Phycis tenuis* (No. 4607, U.S.N.M.). Collected by United States Fish Commission, 1883, station 1157.

One specimen, when removed from the small white cyst, was found to agree in all essential particulars with the specimen from *Menticirrhus*.

10. Cysts from peritoneum of *Phycis chuss*, Woods Holl, Massachusetts, August 29, 1887 (No. 4762, U.S.N.M.).

Blastocyst with very coarse refractile bodies in the parenchyma.

Dimensions of alcoholic specimens: Length of head and neck, about 2 mm.; length of bothrium, 0.37; breadth, 0.32; diameter of neck, 0.24; length of contractile bulbs, 0.47; length of largest broad hooks, 0.044; length of long slender hooks, 0.035.

11. Cysts from *Macrurus bairdii* (No. 4773, U.S.N.M.). Collected by United States Fish Commission, station 894.

Dimensions: Length of blastocyst, 18 mm.; diameter of anterior end, 3; of posterior end, 2; length of embryo, 3.7; diameter of neck, 0.7; length of bothria, 0.75; length of longest hooks, at base of proboscis, about 0.05; length of contractile bulbs, 1.7; longest diameters of calcareous bodies observed, 0.03 (Plate III, figs. 7, 8).

The proboscides are about three times as long as the bothria, sheaths spiral. The arrangement of hooks could not be made out. Hooks of various sizes. Not shaped like those of *R. imparispine*.

III.

The species in this section are distinct for each host.

12. Two lots of cysts from the scup (*Stenotomus chrysops*) were collected at Woods Holl, Massachusetts, August, 1884, and July 23, 1887. On the latter date about a dozen fish were examined and only a few cysts found.

In the first lot the cysts are smaller than they are in the second, but they are evidently the same species.

Dimensions: Length of cyst, 1.1 mm.; breadth of cyst, 0.8; length of embryo, 0.84; breadth, 0.78. Proboscides retracted. Hooks of two kinds (Plate III, fig. 9). Length of longest, slender hooks, 0.023 mm., (Nos. 4775, 4765, U.S.N.M.).

Along with the cyst in the first lot were several slender cysts, with slender blastocyst, whose identity I was unable to determine. One of these measured 6.5 mm. in length, and from 0.18 to 0.46 in diameter. No traces of embryo could be found. Numerous calcareous bodies were present in the interior, some of them showing a concentric structure, others yellowish opaque without distinct structure, average size about 0.05 mm.

An embryo taken from a cyst in the second lot yielded the following measurements, alcoholic specimen: Length of bothrium, 0.76 mm.; breadth of bothrium, 0.4; breadth of head, 1.05; diameter of proboscis at base, including hooks, 0.06; diameter of proboscis in front of tumid base, 0.05; length of shortest hooks, 0.005; length of longest hooks, 0.024.

The bothria have a deep central depression and thick edges, are widely divergent at base so as to appear almost terminal. The approximate length of a proboscis was 2 mm.

During life these embryos, when liberated from the blastocyst, showed the structure with unusual clearness. The muscular retractor of the proboscis was demonstrated (Plate III, fig. 12) and traced to its insertion near the base of the contractile bulbs, and seen to be distinctly fibrous (Plate III, fig. 13). Circular muscles seen in walls of contractile bulbs and also in walls of proboscides. An irregular granular mass near apex of head was probably the nerve ganglion. Two principal branches led back from it, but could be traced for only a short distance.

The surface of the bothria was densely covered with minute bristles.

A granular ribbon with irregular outlines was seen through the transparent walls of the extended proboscides (Plate III, fig. 12 *g*) in the living specimen.

13. This singular specimen (Plate III, figs. 14, 15, 16) was found in a bottle containing specimens of *R. longicorne*, from the spiral intestine of the sand shark (*Carcharias littoralis*), Woods Holl, Massachusetts, August 12, 1887. No notes were made on the living specimen (No. 4763, U.S.N.M.). Dimensions of alcoholic specimen: Length, 4 mm.; breadth of head, 0.37; diameter of neck, 0.28; length of contractile bulbs, 0.04; length of head and neck to base of bulbs, 0.94; length of largest hooks, near base of proboscis, 0.04; length of small hooks, toward apex of proboscis, 0.006. The body is vase-shaped and intimately attached to the neck. Four elongated racemose clusters of oval or pyriform bodies extend from about the front end of the contractile bulbs nearly to the posterior end of the body. The proboscides were retracted, and the character of the hooks could not be made out satisfactorily. The proboscis appears to be swollen at the base. Several large stout hooks, and some straightish ones, at the base of the proboscis; beyond the base the hooks are much smaller.

14. Figs. 17, 18, 19, Plate III, are sketches of a larval *Rhynchobothrium* from a cyst on the liver of the bluefish (*Pomatomus saltatrix*), collected at Woods Holl, Massachusetts, September, 1884.

This specimen (No. 4771, U.S.N.M.) was associated with specimen of *R. speciosum*, but was much smaller than specimens of that species of corresponding degree of development. The length of the entire specimen (fig. 17) was about 11 mm.; the breadth of a bothrium, 0.56.

IV.

In this section are included notices of the occurrence of encysted *Rhynchobothria* whose specific identity could not be determined even approximately, usually on account either of the immature condition of the embryo, or because of the degeneration of the tissues of the blastocyst itself.

15. Cyst from peritoneum of common flounder (*Paralichthys dentatus*), Woods Holl, Massachusetts, August, 1884.

These contained small scoleces of *Rhynchobothrium*; proboscides retracted, hooks of three or more kinds, their arrangement not clearly made out, but their shape and size point to *R. bulbifer*.

16. Small cysts and free embryos found on several occasions as follows, all at Woods Holl, Massachusetts, in the filefish (*Alutera schoepfii*), August, 1884, twice; July 31 and August 12, 1885; July 13 and August 13, 1887; August 5, 1889 (No. 4869, U.S.N.M.). These specimens occur in enormous numbers, appearing as small white specks lying under the serous coat of the stomach and intestine.

They are of various sizes; one measured 1.3 mm. in length and 0.2 in breadth. There are doubtless different species represented among these larvæ.

17. Cysts from walls of stomach and intestine of the sand shark (*Carcharias littoralis*), Woods Holl, Massachusetts, August 2, 1886. These cysts are small, less than 1 mm. in length, containing blastocyst with embryo, too small and young for successful identification, evidently a xenosite (Beneden).

18. (No. 4836, U.S.N.M.) A single blastocyst (Plate IV, fig. 2) from stomach of dogfish (*Mustelus canis*), evidently introduced with the food; stomach with nearly digested fish and crabs. Collected August 1, 1889, Woods Holl, Massachusetts.

The blastocyst was living and active, but embryo not liberated. Length, 14 mm.; diameter, 0.8, of nearly uniform size throughout, slightly swollen at anterior end, which contained a small embryo about 0.048 in diameter at extreme anterior tip. Too rudimentary to identify, but from appearance of blastocyst it is probably a *Rhynchobothrium*.

19. Blastocyst from wall of stomach of sculpin (*Cottus*, sp.) (No. 5497, U.S.N.M.), Woods Holl, Massachusetts, November 11, 1897. Collected by Vinal N. Edwards. Length, 20 mm.; diameter, 1.5; color, yellow. The specimen is filled with crumbling parenchyma, is easily broken, and there is no trace of an embryo.

20. Cysts from sculpin (*Cottus*, sp.) (No. 5498, U.S.N.M.), Woods Holl, Massachusetts, November 6, 1886. Collected by Mr. Vinal N. Edwards. The bottle contains pieces of muscular tissue with a few small fusiform cysts which have degenerated into a waxy and partly calcareous substance, and therefore possess no characters by which they can be classified. It is possible that they may not be *Rhynchobothrium* cysts at all, but sporocysts.

21. Cyst from spleen of squeteague (*Cynoscion regalis*) (No. 5499, U.S.N.M.) Woods Holl, Massachusetts, July 27, 1887.

This cyst was globular in shape and measured 15 mm. in diameter while living, and 12.5 as an alcoholic specimen. It was not opened until it had been in alcohol for sometime, when it was found to contain coagulated parenchyma, but no trace of an embryo could be made out.

22. Cysts from peritoneum of flounder (*Paralichthys oblongus*) (No. 5500, U.S.N.M.), Woods Holl, Massachusetts, August 29, 1887. Cysts contained larval *Rhynchobothria*; proboscides retracted, hooks of various sizes and shapes. Bears some resemblance to *R. imparispine*, but scolex much smaller.

8. RHYNCHOBOTHRIMUM HETEROSPINE, Linton.

(Plate IV, figs. 3-8.)

Rhynchobothrium heterospina, LINTON, Fish Com. Rept., 1887, pp. 839-840, pl. XII, figs. 3-5 (not 6).

Some cysts from the peritoneum of the common eel (*Anguilla rostrata*), collected at Woods Holl, Massachusetts, September 2, 1885, contain embryos which agree in the character of the hooks, the best criterion for determining species in these soft-bodied worms, with *R. heterospine*. Two specimens in alcohol:

Measurements of Rhynchobothrium heterospine.

Dimension.	No. 1.	No. 2.
	<i>mm.</i>	<i>mm.</i>
Length.....	3.20	2.54
Breadth of head.....	.61	.56
Diameter of neck.....	.30	.27
Length of bothrium.....	.59	1.00
Length of contractile bulbs.....	.37	.37
Length of proboscis, approximate.....	1.25	1.25
Length of longest hooks.....	.022	0.22

The retractor muscle of the proboscis is attached to the inner wall of the contractile bulb near the anterior end (figs. 6, 7).

It can hardly be inferred that the eel is the true intermediate host of this parasite. This remark may indeed be properly made for many of the larval parasites found in fishes—where they may be in the condition of what Beneden calls xenosites or strangers.

When a blastocyst was removed from its cyst, it was enveloped in a thin hyaline membrane (fig. 3, *h*). After the embryo was removed from the blastocyst, the latter exhibited signs of life for some time, even attaching itself to the bottom of the glass vessel by its smaller end and dragging itself along.

The embryo when liberated from its blastocyst, had the following dimensions, living: Length, 2.1 mm.; breadth of head, 0.49; length of head, 0.35; diameter of neck, 0.21; length of neck from base of bothria to base of contractile bulbs, 0.94; length of contractile bulbs, 0.42.

The retractor of the proboscis attached to wall of contractile bulb near anterior third of bulb.

9. RHYNCHOBOTHRIMUM IMPARISPINE, Linton. (Larva.)

(Plate IV, figs. 9-12.)

Rhynchobothrium imparispine. U. S. Fish Com. Rept., 1887, pp. 840-843, pl. XII, figs. 6-9.

Following is a list of finds of a tetrarhynch, which I have identified as *R. imparispine*. The principal criterion used in these identifications has been the nature and arrangement of the hooks on the proboscides,

which, being so remarkable, it hardly seems probable that two distinct species could agree so closely in this particular as I find these specimens to do.

1. *Rhynchobothrium* collected at Woods Holl.

No.	U. S. N. M. number.	Date.	Host.
1	.....	Aug. —, 1881	Common Flounder (<i>Paralichthys dentatus</i>), serous coat of intestine.
2	4772	July 31, 1885	Goosefish (<i>Lophius piscatorius</i>), mesentery.
3	4832	July 23, 1886	Tomcod (<i>Mirogadus tomcod</i>), serous coat of intestine.
4	5461	Aug. 6, 1886	Goosefish, mesentery.
5	4743	Aug. 19, 1886	Mackerel (<i>Scomber scombrus</i>), serous coat of viscera.
6	5469	Aug. 10, 1887	Sand Flounder (<i>Bothus maculatus</i>), mesentery, etc.
7	5463	.....do.....	Tantog (<i>Tautoga onitis</i>), serous coat of viscera.
8	.....	Aug. 30, 1887	Goosefish, mesentery, etc.
9	.....	July 30, 1889	Sea Bass (<i>Centropristis striatus</i>), serous coat of viscera.
10	.....	Oct. 7, 1886	Cod (<i>Gadus callarus</i>), collected by S. E. Meek, Block Island.

2. *Rhynchobothrium* collected by Vinal N. Edwards.

No.	U. S. N. M. number.	Date.	Host.
11	4770	Nov. 3, 1882	From mesentery of <i>Lophius piscatorius</i> .
12	5462	Dec. 1, 1885	Peritoneum of <i>Melanogrammus aeglefinus</i> .
13	.....	Dec. 16, 1885	Do.
14	4770	Nov. 4, 1886	Mesentery of <i>Lophius piscatorius</i> .
15	4770	Oct. 14, 1887	Do.
16	4756	Oct. 24, 1887	Peritoneum of <i>Acanthocottus aeneus</i> .
17	4755	Nov. 28, 1887	Peritoneum of <i>Gadus callarias</i> .
18	4755	Dec. 24, 1887	Do.
19	4755	June 24, 1888	Do.

This parasite occurs in cysts that are usually pyriform and sometimes attached to the serous membrane by a pedicel. The bothria are very versatile and deeply notched on distal end so as to appear in some instances to be distinct bothria.

Following are extracts from notes made on individual lots, numbers referring to foregoing list:

Numbers 2, 4, 8, 11, 14, 15. From *Lophius piscatorius*. The cysts are subglobular or pyriform; one in lot 11 measured 11 mm. in length and 5 mm. in greatest breadth; hooks on proboscides in No. 15 (fig. 12) not very clearly seen on account of the proboscides being retracted; large stout hooks 0.06 mm. in length and 0.04 in breadth at base. No. 2 (figs. 9-11), freehand sketches from life; cysts pyriform, blastocyst oblong, remaining firmly attached to embryo, when latter is liberated, to form a nutrient sac. The latter is filled with coarse granular parenchyma with fluid refractile bodies. In one lot the hooks in one specimen were sparsely scattered, which may be due to imperfect development.

The peritoneum of each of the three fish examined was filled with transparent subglobular cysts, averaging about 6 mm. in diameter. The blastocysts were nearly globular when at rest, but capable of much change of form by contraction. The embryo could be seen as a

small opaque mass near the surface of the blastocyst. In the walls of the latter were two sinuous vessels which started from the vicinity of the embryo and ran in opposite directions around the periphery of the blastocyst. No. 6 from *Bothus maculatus*. In this the longest hooks, however, are 0.04 mm. in length. Other dimensions of an embryo (alcoholic) are: Length, 6 mm.; breadth of head, 0.94; length to base of contractile bulbs, 4; diameter of neck, 0.47; length of bulbs, 1; diameter of proboscis, exclusive of hooks, 0.08. No. 7 from the tantog. The arrangement and character of the hooks in this also agree exactly with that of the foregoing; the length of the large stout hooks is 0.05 mm. Other dimensions practically the same as in No. 6. No. 5 from the mackerel. The cysts in this lot are of great diversity of shape. Two embryos were examined, and although the proboscides were retracted the characteristic irregular hooks of *R. imparispine* could be seen. The length of the longest hooks seen was 0.04 mm. in one and 0.035, near base of proboscis, in the other. No. 9 from sea bass. Cysts pyriform, blastocysts with embryo situated at one end; proboscides retracted, but hooks correspond with *R. imparispine*.

Nos. 10, 16, 17, and 18 from the cod and Nos. 12 and 13 from the haddock. The cysts are pyriform and in many instances pediceled; in No. 16 there was a cluster of pyriform cysts. When embryos were liberated, the arrangement and character of the hooks proved to be identical with those figured from other hosts and referred to *R. imparispine*.

10. RHYNCHOBOTHRIMUM SPECIOSUM, new species.

(Plates IV, figs. 13-14; V, figs. 1-7.)

Rhynchobothrium, sp.. LINTON, Amer. Nat., XXI, p. 195, Feb. 1887, pl. x, figs. 1-6.

I venture to give a new specific name to a *Rhynchobothrium* which I have found very commonly infesting the bluefish and not infrequently in a variety of other fish. Although only the larval form is known to me at present, the characters of the bothria, and particularly of the proboscides, are so well defined that one can hardly fail to identify it when specimens in good condition and sufficiently developed are met.

Following is a list of the finds of this parasite which I have recorded in my notes. All except Nos. 9, 10, and 11 were collected at Woods Holl, Massachusetts. Where not otherwise stated, it will be understood that the specimens were found on the serous covering of the viscera or mesentery.

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List of specimens.

No.	U.S.N.M. No.	Date.	Host.
1	Aug. —, 1884	Common Flounder (<i>Paralichthys dentatus</i>).
2	.....	.....do.....	Bluefish (<i>Pomatomus saltatrix</i>), on ovaries, etc.
3	.....	Aug. 19, 1885	Scup (<i>Stenotomus chrysops</i>).
4	4766	July 27, 1886	Garfish (<i>Tulosurus caribbæus</i>).
5	5469	Aug. 5, 1886	Bluefish (<i>P. saltatrix</i>).
6	4790	.....do.....	Squeteague (<i>Cynoscion regalis</i>).
7	.....	Aug. 19, 1886	Mackerel (<i>Scomber scombrus</i>), 20, walls of stomach and intestine.
8	4819	Oct. —, 1886	Moon fish (<i>Chaetodipterus faber</i>), North Carolina coast, S. E. Meek, collector.
9	.....	.....do.....	Bluefish (<i>P. saltatrix</i>), Massachusetts coast, S. E. Meek, collector.
10	4768	.....do.....	Squeteague (<i>C. regalis</i>), Massachusetts Bay, S. E. Meek, collector.
11	5466	July 26, 1887	Remora (<i>Echeneis remora</i>).
12	4753	July 29, 1887	Bluefish (<i>P. saltatrix</i>).
13	5471	Aug. 1, 1887	Remora (<i>E. remora</i>).
14	5464	July 9, 1889	Bluefish (<i>P. saltatrix</i>).
15	5465	July 26, 1889	Do.
16	5470	July 30, 1889	Do.
17	4735	Aug. 17, 1889	Do.

I reproduce, with the omission of many details, the description of this species contained in the article in the "American Naturalist."¹

Cysts like this—i. e., containing an embryo rhynchobothrium, either of the same or kindred forms—are common in most of the teleostei, and are occasionally found in selachians. In the specimen under consideration (a cyst from the peritoneum of the bluefish) the length was 12 mm., and the breadth in the widest part 6 mm. The cyst was clavate, its walls thin, transparent, and delicate, with yellow granular patches at the larger end. It was easily separable into two hyaline connective-tissue layers, the outer thicker than the inner.

The blastocyst when released from its capsular envelope was white and opaque, but became translucent, with a faint bluish tinge when compressed and viewed by transmitted light. The form, while somewhat variable, is usually club-shaped, much larger at one end than the other, the larger end blunt and rounded. When placed in sea water, it continues in a state of activity for hours. There is no decided locomotion, but a continuous series of movements, consisting of alternate contraction and extension of different parts of the sac-like mass and feeble lateral movements of the smaller end. In this condition the appearance of the blastocyst is that of a thick-walled sac, the walls of which are made up of granular protoplasm, with a thin investing membrane, and filled with clear, highly refractile globular masses. When slight pressure is applied, the embryo may be seen lying in a loose coil in the larger end of the blastocyst. Two sinuous vessels, one on each side, can be plainly seen lying along each side. These unite in the median line at the smaller end. At the larger end they appear to be lost in the common parenchyma. In the immediate vicinity of the embryo the blastocyst is more transparent than in other parts, and the

¹ February, 1887, pp. 199, pl. x.

embryo appears to be held in place by a limiting membrane, which lines the blastocyst and surrounds the embryo. When considerable pressure is applied, the embryo is forced through the walls of the larger end of the blastocyst, with which it no longer retains vital connection.

The irritability and contractility of the blastocyst continue for several hours after the embryo has been removed. The embryo when removed from the blastocyst was quite active, its length about 24 mm., although capable of considerable variation both by contraction and extension. The bothria are two in number, oblong-elliptical, widely divergent behind, approaching but not uniting in front; emarginate on posterior border and obscurely two lobed (alcoholic specimens show a distinct longitudinal median ridge); edges free, thin, and mobile. Length of bothria, measured while somewhat flattened under compressor, 2.23 mm.; breadth of head, 2.72. Proboscides, four, very long, slender, cylindrical, and armed with recurved hooks of different sizes. The proboscides, in this instance, were not entirely everted, but by counting the series of hooks which were exposed, and allowing for the part which was inverted, which could be plainly seen through the transparent walls of the proboscis, the result was about one hundred series of hooks arranged in spirals. The spirals are nearly 0.05 mm. apart, and the proboscides about 4.8 in length. There are about fifteen longitudinal rows of hooks. These rows do not coincide exactly with the axis, but make about one and a half turns around it from base to apex. Their arrangement is shown in the accompanying sketch (Plate V, figs. 1-6).

The proboscis sheaths are long and spiral. A contractile ligament was clearly defined in each and could be traced out into the proboscis, where it appeared as a tubular band containing a fluid in which floated a few granules. Toward the end this tubular ligament merged imperceptibly in the proboscis, and the fluid interior with granules became the exterior of the proboscis inverted, with, at first, small and scattered rod-like hooks, and, toward the apex of the inverted proboscis, with normal hooks attached to the inner parietes.

The front ends of the contractile bulbs lie about 10 mm. back of the apex of the head; length 2.46, and breadth 0.24. The thick walls are composed of diagonal muscular fibers which interlace, making angles of about 70 and 110 degrees with each other. These organs act much as the bulb of a syringe. By their contraction the fluid contents is forced into the proboscis sheaths and proboscides. The column of fluid thus forced into the proboscides causes them to unroll like the finger of a glove that has been turned in. The contractile ligament, noticed above, extends the entire length of the proboscis sheath and is attached to the inner parietes of the bulb. By its contraction the proboscis is invaginated from the apex. When the embryo was first liberated, the proboscides were entirely retracted; when, however, pressure was applied, they unrolled. In this condition the proboscides

of the living worm are very beautiful objects, being quite transparent, while the chitinous hooks have a brilliant vitreous luster. When fully extended, the proboscides throw themselves into graceful spiral curves. When the pressure is released, if the worm is uninjured, they are apt to be withdrawn.

The tubular neck, when flattened under the compressor, presents the following features: The center surrounding the proboscis sheaths is filled with large irregular granular masses, closely packed together. Outside of this inner core is a layer of longitudinal muscles, and outside of this again a layer of vascular tissue, in which the reticulated vessels of the water vascular system can be plainly seen. Outside of the vascular area, and forming the outer coat of the neck, is a layer of dense tissue in which transverse fibers could be distinguished.

The water vascular system consists of a network of vessels in the borders of the bothria which connects with large sinuous vessels in the center of the head, and, together with these, with the reticulated subcuticular vessels of the neck. Back of the contractile bulbs the system is represented mainly by two pairs of vessels which lie in two sinuous curves near each lateral margin of the embryo. One of these vessels was much larger than the other and ended in a bulbous enlargement.

Behind the contractile bulbs the body has the appearance of an elongated sac, filled with granular parenchyma, but with the retractile bodies much smaller than those in the blastocyst. The posterior end terminates in a papillary button-like process, which is retractile and covered with a dense coat of minute, straight, hair-like bristles.

I add a few extracts from notes on some of the foregoing lots. The general account already given was based on specimens from the bluefish.

No. 3. Dimensions of specimen, alcoholic, from senp: Length, 27 mm.; length of head and neck, 13; length of bothria, 2; breadth of bothrium, 1.6; breadth of neck, 1.5; thickness of neck, 1; diameter at contractile bulbs, 2.5; diameter behind contractile bulbs, 1.7; tapering from behind contractile bulbs to posterior tip, which is 0.5 mm. in diameter. The hooks agree exactly with those on larva from the bluefish.

No. 10. Cyst from liver of squeteague: Length 30, mm.; diameter of first third of length, 3.5, tapering thence rather abruptly to posterior end, 1.5. Embryo coiled in larger end; length, estimated, 13.5. Hooks agree exactly with type; length of longer ones, 0.53.

No. 9. Cyst from abdominal cavity of moonfish: Long pyriform, length, 20 mm.; greatest diameter, 4.5; embryo coiled in anterior fourth; length of embryo, 12; of head and neck, 4.6; diameter of neck, 1.5; length of bothrium 1.5, and breadth of bothrium 1.25. Bothria elliptical with posterior emargination and median longitudinal elevation; neck cylindrical with a few transverse wrinkles; hooks agree with type—largest 0.05 mm. in length.

Nos. 11 and 13. From serous covering of viscera of remora. These agree exactly with type. The cyst in No. 11 was dark reddish brown, translucent except at small end, which was almost black. Length, 36 mm. and greatest diameter 5; length of blastocyst 26, and greatest diameter 4.5; very active and changeable. After lying overnight in sea water, the blastocyst having become quiescent, the embryo was set free. It was active and varied in length from 20 to 25 mm. Further dimensions were: Length of head and neck, 9 mm.; length of contractile bulbs, 2.7; diameter of contractile bulbs, 0.32; length of proboscides, approximate, 4.8; diameter of proboscides, 0.12.

Proboscides very long, slender, and graceful, having tendency to coil up; larger hooks on inner side of coil, smaller on outer side; arrangement of hooks typical.

No. 1. From common flounder, on viscera, typical. Edges of bothria often reflected and face of bothrium hollowed out. The posterior emargination and median ridge are best seen in alcoholic specimens.

11. RHYNCHOBOTHRIMUM ATTENUATUM, Rudolphi.

(Plate V, figs. 8-11.)

Rhynchobothrium attenuatum, DIESING, Syst. Helm., I, p. 568; Revis. d. ceph. Ab. Param., p. 307.

No. 5459, U.S.N.M., parasites of swordfish (*Xiphias gladius*).

1. Off Marthas Vineyard, Massachusetts, July 25, 1887; numerous specimens from peritoneum (No. 4761, U.S.N.M.).

2. Three specimens collected by Professor W. Libbey, schooner *Grampus*, July 24, 1889.

3. Sixteen specimens, No. 4715, U.S.N.M., September 21. Trawl line U. S. Fish Commission from outside stomach and intestine of swordfish.

4. Twenty specimens, No. 4714, U.S.N.M., from outside stomach of swordfish.

These worms agree with Diesing's descriptions of this species, and resemble Leuckart's¹ figure of his *Bothriocephalus clariger*, which is placed by Diesing under *T. attenuatus*, Rudolphi, in his *Systema Helminthum*, but transferred to the genus *Rhynchobothrium* in the Revision, with the following description: "Head ovate-conical, with conical lateral bothria, bilocular by a longitudinal septum. Proboscides straight, clavate. Neck very long, decreasing behind, sometimes transversely rugose, joints of the body papilliform."

These larvæ are grub-like in appearance, the proboscides short and thick, the hook-bearing portion being but little longer than broad. Hooks of different shapes, but differing gradually from one part of proboscis to another—better shown in sketch than in a written description. The proboscides are in pairs at the apex of the bothria; the latter are on the sides of the head, which correspond with the flat surfaces of the neck.

¹ Zool. Bruchst., I, pp. 51, 62, pl. II, fig. 32.

I append the following extracts from notes made on the above several lots:

1. Length of one in fresh water, 64 mm.: greatest breadth, near head, 10; least breadth, 5; constantly altering its shape. Another, in salt water, measured 103 mm., and another 130. Length of proboscis, 1.58; breadth of proboscis, 1.16; length of hooks, 0.018; length of contractile bulb, 4.73; breadth, 0.88.

2. Specimens had been hardened in Perenyi's fluid. Largest, length, 72 mm.; greatest breadth, 7. Another, length, 56; greatest breadth, 8.

3. Of nearly uniform size, alcoholic specimens, length, 50 mm.; breadth, 6.

Three specimens of *T. bicolor* were found in this lot with their heads penetrating the bodies of *R. attenuatus*.

4. The largest specimen in this lot (alcoholic) had the following dimensions: Length, 62 mm.; breadth of head, 5.5; thickness of head, 4; greatest breadth, 9.

A large cyst was found in this lot, 37 mm. long, 36 broad, and 12 thick, which contained a coiled larva, apparently the same as the free larva, but it had undergone a kind of waxy degeneration to such a degree as to obliterate specific characters. This cyst had a pedicel about 60 mm. in length.

A few other waxy cysts, smaller than the above, were included in the lot.

12. OTOBOTHRIMUM DIPSACUM, new species.

(Plate VI, figs. 1-5.)

I record under the above new specific name the following notes made on a unique tetrarhynch embryo from a cyst in a bluefish (*Pomatomus saltatrix*), (No. 4794, U.S.N.M.).

The cyst was oval, about 12 mm. in the longer and 6 in the shorter diameter, and consisted of an outer transparent coat, separable with needle points into two layers, and an almost opaque, granular, dirty-yellow coat, which appeared to be lined with a very delicate transparent membrane. The blastocyst when liberated was found to be pear shaped, translucent white, beautifully reticulated, 8.5 mm. long, 6 in diameter at the larger end, and tapering through an offset to a blunt point. At the middle of the base there was a puckered appearance, due, apparently, to radiating contractile fibers. The blastocyst was constantly undergoing changes of form, which had the appearance of being caused by spasmodic contraction of the semifluid parenchyma with which it was abundantly supplied. When the embryo was liberated from the blastocyst, it had the following dimensions, slightly distorted by compression:

Dimension of *Octobothrium dipsacum*.

Measurements.	Living.	Alcoholic.
	mm.	mm.
Length.....	5.00	3.00
Length of bothrium.....	1.80	1.00
Length of contractile bulbs.....	2.00	1.40
Diameter of contractile bulbs.....	.32	.18
Diameter of proboscis.....	2.60	1.30
Length of proboscis (approximate).....	.12	.12
Diameter of proboscis, exclusive of hooks.....	.22	.21
Diameter of proboscis, including hooks.....	.05	.05
Length of longest hooks.....		

The proboscides were not seen fully extended, but so far as unrolled they were clavate.

The bothria were four, in pairs. Each bothrium is provided on its posterior edge with a small cup-shaped organ, about 0.01 mm. in diameter, which is eversible. When slight pressure was applied, these organs were everted, when they appeared as small tubercles covered with exceedingly fine, short, stiff-looking bristles, about 0.002 mm. in length.

Behind the contractile bulbs, at the posterior end of the embryo, is a short papillary projection, covered with very fine downy bristles.

The neck of the living embryo is translucent, and has the following characters in optical section: There is first an outer granular layer 0.002 mm. thick, next a layer of transverse fibers 0.07 thick, next a layer of longitudinal fibers 0.025 thick. Within is a central space filled with a granular parenchyma containing numerous refractile bodies. In this central space also the branching and anastomosing vessels of the water vascular system and the proboscis sheaths with their retractile muscles can be made out.

The arrangement of the hooks on the proboscides is characteristic (figs. 2, 3), in that each has a longitudinal line toward which the shorter diagonal rows of hooks converge on each side. Near the base of the proboscides, where the hooks are somewhat scattering, from six to ten hooks to a row could be counted on each side of the horizontal line, under favorable circumstances. More than twice that number could be counted in the rows nearer the apex of the proboscis.

13. Genus TETRARHYNCHUS.

(Plate VI, figs. 6-10.)

I group together under this head a number of larvæ from a variety of hosts, some of which undoubtedly belong to this genus, but which I am unable to identify certainly with any adult form; others may not belong to the genus at all, notably numbers 7 to 11.

1. Small cysts from serous coat of stomach of the dusky shark (*Carcharhinus obscurus*) (No. 5480, U.S.N.M.), twice in August, 1884, and again, July 25, 1887, Woods Holl, Massachusetts.

Dimensions of alcoholic specimen.—Length of cyst, 0.47; diameter of cyst, 0.27; length of blastocyst, 0.3; diameter of blastocyst, 0.12; length of contractile bulbs, 0.086; diameter, 0.043; diameter of proboscis, about 0.02; hooks very small, about 0.01 in length.

Proboscides slender, hooks strongly recurved. Possibly young stage of *Tetrarhynchus robustus*, Linton.

2. Minute cysts from intestinal walls of hammerheaded shark (*Sphyrna zygaena*) (No. 5479, U.S.N.M.), Woods Holl, Massachusetts, July 28, 1886. Length of blastocyst, 0.56 mm.; diameter at larger end, 0.45, tapering to a blunt point at the smaller end. Embryo a small granular mass, near larger end 0.09 mm. in diameter.

3. Small cysts from the cero (*Scomberomorus regalis*) (No. 5494, U.S.N.M.), collected at Woods Holl, Massachusetts, August 12, 1886; July 30, 1887; August 9 and August 13, 1889.

Dimensions of alcoholic specimen slightly compressed.—Length of cyst, 1 mm.; breadth of cyst, 0.75; length of larva, 0.33; length of bothrium, 0.13; breadth of head, 0.17; length of contractile bulbs, 0.09; breadth, 0.066; hooks very minute, about 0.005 in length.

Possibly young stage of *Tetrarhynchus tenuis*, Linton (No. 4819, U.S.N.M.).

4. *Tetrarhynchus chatodipteri*, from abdominal cavity of *Chatodipterus faber*, North Carolina coast, October, 1886, collected for the United States Fish Commission by S. E. Meek, Fulton Market, New York. The cysts were in small clusters in the abdominal cavity of the host. One cluster was 12 mm. long and 7 broad—all the cysts small; a typical one measured 1.7 mm in length and 0.88 in breadth.

Dimensions of cyst and embryo.—Length of cyst, 1.3 mm.; breadth, 0.7; length of embryo, 1.14; length of bothria, 0.38; length of contractile bulbs, 0.31 diameter of bulbs, 0.15; diameter of proboscis, exclusive of hooks, 0.017; length of longest hooks, 0.011. The inner face of the proboscis bears extremely small bristle-like hooks. The outer face bears, for the most part, rather stout, recurved hooks (Plate VI, fig. 9.).

5. Cysts from stomach wall of the sting ray (*Trygon centrura*) (Nos. 5477, 5478, 5481, U.S.N.M.), collected at Woods Holl, Massachusetts, August 14, 1885, July 27, 1886, July 18, August 3 and 10, 1887, and July 24, 1889.

The cysts are small and contain small subconical blastocysts, which have a rudimentary embryo near the larger end.

Dimensions of alcoholic specimens.—Length of blastocyst, 1.44 mm.; diameter at larger end, 0.94; diameter at smaller end, 0.16; length of embryo, 0.144; diameter of embryo, 0.08. Calcareous bodies are present in the blastocysts, and some cysts were found in which the contents had degenerated. Two cysts, belonging one to each of the first two lots, are larger than dimensions given above—3.5 mm. in length. For the others the dimensions given are typical.

In all cases the embryo was too rudimentary to allow of even approximate identification.

6. Cysts (Nos. 4838, 4822, U.S.N.M.) from stomach wall of the dogfish (*Mustelus canis*), collected at Woods Holl, Massachusetts, July 22, 1886, and July 22 and 25, 1887. In most cases these cysts are small with rudimentary embryos, in which the proboscides are too rudimentary to be of value in determining specific characters. A typical cyst measured 1.5 mm. in diameter and contained a blastocyst 1.04 mm. in length and 0.8 broad.

In one lot embryos were obtained from blastocysts (alcoholic specimens), which gave the following measurements: Length, 1.3 mm.; diameter, 1.1; diameter of proboscis, exclusive of hooks, 0.034; diameter, including hooks, 0.06; length of hooks, 0.019 (Plate VI, figs. 6, 7).

These larvæ bear a strong resemblance to *R. robustum*, Linton.

7. Cysts from intestinal wall of common skate (*Raja erinacea*) (No. 5482, U.S.N.M.). Woods Holl, Massachusetts, August, 1884, twice. No embryos. Cysts in first lot filled with amber-colored waxy secretions.

The second find consisted of an elliptical cyst in the liver, $3\frac{1}{2}$ by $2\frac{1}{2}$ mm. in diameter, and about 1 thick; reddish brown. Contained roundish granular masses from 0.16 to 0.40 mm. in diameter. Cyst had a pedicel which contained quantities of blood corpuscles of the host. This may be a sporocyst.

8. Small cysts from gill of goosefish (*Lophius piscatorius*) (No. 5476, U.S.N.M.), Woods Holl, Massachusetts, July 18, 1885.

These cysts were from 1 to 2 mm. in diameter, contained masses of carbonate of lime, and could not be identified.

9. Cysts from serous coat of intestine of billfish (*Tetrapturus imperator*) (No. 5501, U.S.N.M.), Woods Holl, Massachusetts, July 31, 1895.

These cysts were filled with chocolate-colored waxy secretions. They were evidently caused by the presence of a parasite which had undergone complete degeneration of tissue.

10. Cysts from peritoneum of flounder (*Pseudopleuronectes americanus*) (No. 5502, U.S.N.M.), Woods Holl, Massachusetts, August 23, 1886, and August 10, 1887. These cysts are from 2 to 3 mm. in length and look like tetrahyinchus cysts. Many of them are entirely or partly degenerate, containing much carbonate of lime, and in no case could the exact nature of the cyst be made out.

11. No. 4837. Cysts from peritoneum of butterfish (*Stromateus triacanthus*), Woods Holl, Massachusetts, July 23 and August 24, 1887. Small cysts less than 2 mm. in length, which contained an elongated blastocyst (?) from 1 to 2.4 mm. in length. Some of these had an aperture at larger end. The cysts had yellowish granular walls, and inclosed the blastocyst (?), which was itself twisted in a transparent membranous sac. The chyle of the intestine of the first lot was found to contain numerous examples of these embryos—i. e., identical with the blastocysts (?) above.

14. TETRARHYNCHUS BISULCATUM, Linton.

(Plate VI, figs. 11-15.)

Rhynchobothrium bisulcatum, LINTON, U. S. Fish Com. Rept., 1886, pp. 479-486, pl. iv, figs. 9-23; U. S. Fish Com. Rept., 1887, pp. 857-861, pl. xiv, figs. 10-12, and pl. xv, fig. 1.

I have found a larval *Tetrarhynchus*, which I refer to this species, on a number of occasions and in a variety of hosts.

Tetrarhynchus bisulcatum, collected at Woods Holl, Massachusetts.

No.	U.S.N.M. number.	Date.	Host.
1	July —, 1884	Common flounder (<i>Paralichthys dentatus</i>), stomach wall.
2	4826	Aug. —, 1884	Squeteague (<i>Cynoscion regalis</i>), stomach wall.
3	4834	July 23, 1886	Do.
4	July 30, 1886	Do.
5	4823	July 14, 1887	Torpedo (<i>Tetranarce occidentalis</i>), in pylorus.
6	Aug. 24, 1887	Flounder (<i>P. dentatus</i>), stomach wall.
7	Aug. 30, 1887	Scup (<i>Stenotomus chrysops</i>), stomach wall.
8	Sept. 2, 1887	Flounder (<i>P. dentatus</i>), stomach wall.
9	July 16, 1889	Do.
10	July 20, 1889	Squeteague (<i>C. regalis</i>), stomach wall.
11	July 27, 1889	Do.
12	Aug. 16, 1889	Rudder-fish (<i>Seriola zonata</i>), stomach wall.
13	Aug. 19, 1889	Squeteague (<i>C. regalis</i>), stomach wall.
14	Aug. 27, 1889	Flounder (<i>P. dentatus</i>), stomach wall.
15	Aug. 28, 1889	Do.

There were many finds from squeteague not included in the above list. The favorite lodgment of this parasite is between the submucous and mucous layers of the stomach. I have found it very abundant in the squeteague at Woods Holl, Massachusetts, and have seldom examined one of these fish without finding numerous examples of encysted tetrarhynchs in the stomach walls.

The specimens from the squeteague appear to be typical scoleces of *T. bisulcatum*. An alcoholic specimen yielded the following measurements: Length of scolex, 1.6 mm.; diameter of head, 0.94; length of contractile bulbs, 0.42; diameter of proboscis, including hooks, 0.053; length of longest hooks, 0.023.

The cysts are small, oval; the blastocyst is also oval and is filled with semifluid parenchyma with retractile granules. The embryo lies at one end with the head pointing outward. It consists of the bothria and short conical neck, the latter fitting over a very short terminal part like a collar.

A specimen from the flounder agrees, in general appearance and in character of hooks, with type (alcoholic specimen): Diameter of proboscis, including hooks, 0.062 mm.; length of hooks, 0.019.

The specimen from the rudder-fish has a tumid neck, making it short fusiform instead of conical, the usual shape.

The specimen from the scup agreed in general appearance. The proboscides were retracted, only a few basal hooks showing. These were small, 0.015 mm. in length.

The specimen from the torpedo was found in the pyloric division of the stomach; only the scolex present. It presents some differences from typical scoleces of *T. bisulcatum*, the proboscides being stouter than usual for that species. The proboscides were retracted and only the short hooks at base of proboscis were seen at first; their length was 0.014 mm. The specimen was then made transparent with oil of cloves and the hooks found to agree in size and shape with those of *T. bisulcatum* (figs. 13, 14) (No. 4834, U.S.N.M.).

15. TETRARHYNCHUS ERINACEUS, Beneden.

(Plate VII, figs. 1-8.)

Tetrarhynchus erinaceus. BENEDEN, Mem. Vers. Intest., pp. 128-131, 367, pl. XVIII; Les Pois Belg., pl. v, fig. 12; pl. vi, fig. 3.—OLSSON, Lund's Univ. Arsskrift, III, p. 50, pl. II, figs. 42-44.

A species which has hooks that bear a strong resemblance to those of *Rhynchobothrium imparispine*, Linton, but with a cystic habit much like that of *Synbothrium filicolle*, occurs twice in my collection and once in the United States National Museum collection:

Tetrarhynchus erinaceus.

No.	U. S. N. M. number.	Date.	Host.
1	4824	Aug. —, 1884	Squeteague (<i>Cynoscion regalis</i>), outside of ovary.
2	4830	July 29, 1889	Bluefish (<i>Pomatomus saltatrix</i>), serous coat of viscera.
3	4828	.....	Squeteague (<i>C. regalis</i>), serous coat of viscera.

The first and last are encysted blastocysts of the type of *Synbothrium* (fig. 1).

Dimensions of specimens from lot No. 1 (alcoholic).—Length of blastocyst, 40 mm.; length of anterior division, 2.5; diameter of anterior division, 2; average diameter of posterior division, 1.5; breadth of head of embryo, 0.76; length of thick, strong hooks, 0.09; length of small, slender hooks, 0.015; length of small hooks, 0.008. Color of posterior division, opaque white; of anterior division, yellowish white.

No. 3 consists of a single blastocyst, same type as No. 1. Dimensions, alcoholic specimen: Length, 22 mm.; length of anterior part of blastocyst, 3; diameter of same, 2.5; diameter of posterior part, 1.5; breadth of head, 0.72; diameter of neck, 0.5; length of large stout hooks, 0.06 to 0.08; length of small hooks, 0.01 to 0.03; diameter of proboscis, exclusive of hooks, 0.1; length of embryo proper, 6; length of contractile bulbs, 1.8. Posterior part of blastocyst, white; anterior, brownish yellow. The hooks have the following arrangement: Two longitudinal rows of large, stout, strongly recurved hooks, flanked on each side by two rows of smaller and slenderer hooks, also strongly recurved; these again by two rows of slender hooks, those in the inner row sharp-pointed, those in the outer row flat with truncate or notched tips. These ten rows of large hooks cover a little more than half the

circumference of the proboscis. The remainder of the surface is covered with minute hooks placed close together. These minute hooks also extend for a short distance between the spirals of larger hooks, where they are a little larger than they are on the outer surface of the proboscis. The larger spirals are about 0.09 mm. apart.

No. 2 (fig. 6), sketch of alcoholic specimen, embryo detached from blastocyst to which it was firmly adherent; from *Pomatomus saltatrix*. The bothria are doubtless distorted. The sketch was made with the aid of a camera lucida, and represents exactly the appearance of the embryo. It is quite different from other embryos, having the characteristic hooks of *R. erinaceus*. Figure 7 is a sketch of a portion of a proboscis of this specimen. It will be seen that it agrees with the specimen from *C. regale* in every essential particular. Dimensions of this interesting alcoholic specimen are as follows: Length, 2 mm.; breadth of head, 1.08; diameter of neck, 0.34; length of contractile bulb, 1; diameter of proboscis, excluding hooks, 0.09; length of stout hooks, 0.09; breadth of same, middle of hook, 0.038; length of long, slender hooks, 0.106; length of shortest hooks, 0.005.

16. TETRARHYNCHUS ELONGATUS, Wagener.

(Plate VII, figs. 9-12.)

Anthocephalus elongatus, WAGENER, Nov. Act. l. c. 57 and 81, pl. XVII, fig. 217; XVIII, fig. 218.—DIESING, Revis. d. ceph. Ab. Par., p. 313.—OLSSON (*Tetrarhynchus*, statu scolecis), Lund's Univ. Arsskrift, IV, p. 9, pl. III, fig. 63.—LEIDY, Proc. Acad. Nat. Sci. Phil., 1890, p. 282.

Under this title, I notice some larva of tetrarhynchus from the liver of the sunfish (*Mota rotunda*).

The specimens (No. 5484, U.S.N.M.) were obtained from the United States Fish Commission, having been collected off Marthas Vineyard, Massachusetts, September 10, 1886, and sent to me for identification. I therefore have seen them only in the condition of alcoholic specimens. The specimens were still in the liver, which was, in places, tunneled out by the parasites, and the latter were much broken, so that none of them could be taken out entire.

The blastocysts are subspherical at the anterior end, which contains the head and neck of the embryo. The posterior end is elongated into a slender cylindrical body. When the head and neck portion is liberated from the anterior end of the blastocyst, it still remains in connection with the posterior slender part of the blastocyst.

The diameter of the rounded anterior portion of one blastocyst was 5 mm. The posterior slender portion, so much of it as was extracted from the liver of the host, measured 65 mm. in length and 1.5 in diameter.

One of the globular enlarged portions of a blastocyst was placed in glycerine and left until thoroughly softened, then opened carefully, and the embryo uncoiled. It was found to be continuous with the

slender posterior part, all being inclosed in a thin transparent covering. No sign of segmentation was observed.

The most characteristic feature is the prolongation of the anterior ends of the bothrial lobes to form the unarmed basal portion of the proboscides.

A specimen, slightly compressed, yielded the following measurements: Length of bothria, 2.2 mm.; breadth of head, 1.6; length of anterior prolongation of bothria, 1.8; diameter of same, 0.34; length of proboscides, estimated from retracted organ, 6.75; length of contractile bulbs, 2.4; diameter of same, 0.34; length of longest hooks, 0.12.

Hooks were seen only on the retracted proboscides. They are of very diverse shapes, a few of which are shown in figure 12. The arrangement could not be made out exactly. There is a cluster of small bristle-like hooks near the apex (*a*), preceded at extreme tip by a few large horn-shaped hooks (*b*). The most abundant type is long, slender, and slightly curved (*d*). The type (*c*) constitutes three or four longitudinal rows throughout the length of the proboscis.

17. TETRARHYNCHUS BICOLOR, Bartels.

(Plate VIII, figs. 1-6.)

Bothriocephalus bicolor, BARTELS, Diesing, Syst. Helm., I, p. 608.

Tetrarhynchobothrium bicolor, DIESING, Revis. d. ceph. ab. Par., pp. 316, 317.

I refer to this species five different lots of larvæ of tetrarhynchus from four species of fish.

1. From the dolphin (*Coryphæna hippurus*) (No. 5483, U.S.N.M.). The specimens in this lot were collected August 13, 1885. The fish had been taken on the Gulf Stream a day or two before: Numerous on peritoneum and mesentery.

2. (No. 4820, U.S.N.M.) From the swordfish (*Xiphias gladius*), off Marthas Vineyard, Massachusetts, July 25, 1887: three specimens from peritoneum.

3. (No. 4817, U.S.N.M.) From the dusky shark (*Carcharhinus obscurus*), Woods Holl, Massachusetts, August 12, 1887: one specimen adhering to mucous membrane in pylorus.

4. (No. 4825, U.S.N.M.) From the tiger shark (*Galeocerdo tigrinus*), Woods Holl, Massachusetts, August 14, 1889; five specimens from stomach.

5. (No. 4829, U.S.N.M.) From the swordfish, peritoneum and mesentery; four specimens. Label reads: "September 21, Trawl line, U. S. Fish Commission."

These specimens present considerable difference in size and general appearance of the scoleces, but apparently are absolutely identical in the arrangement of hooks on the proboscides. The character of the proboscides being so peculiar, particularly the nature of the hooks on the base of the proboscis, that where, as in these cases, only the

scoleces are available, I do not feel justified in referring them to different species.

The description of this species given by Diesing is:

Head oblong, cylindrical, violaceous, with four narrow oblong bothria immersed in the head, transversely rugose. Proboscides very slender and short. Neck cylindrical. Body very short, articulated, posteriorly rounded. Genital aperture in median furrow of body.

I must confess to no small degree of difficulty in the classification of these forms, the descriptions of *T. rugosum*¹ and *T. bicolor* applying equally well. Besides, there is a great diversity of form in the scoleces themselves, so that the difficulty of classification is not lessened by referring them to different species.

The specimens from *Coryphæna hippurus* were found, some encysted and some free, in the peritoneum and mesentery of their host. I have no mention of color in my notes made at the time of collection. My recollection is that they were the ordinary yellowish white, so common among allied forms. The arrangement of the hooks on the proboscides agrees with that shown in figures from *Carcharias*: About seven hooks visible in a spiral on one side near middle of proboscis, about six near apex, and about eight near base, while at the base are the characteristic uncinatæ plates shown in the sketch; length of proboscis, about 1 mm. The alcoholic specimens vary in length from 4 to 8 mm., and in shape from ovate to oblong-linear, according to state of contraction; usually corrugated, though not always, some of the smaller nearly smooth. The larger specimens show distinct bothria.

In the specimens for *Xiphias gladius*, the proboscides, while relatively more slender than in those from *Coryphæna*, the arrangement and character of the hooks appear to be identical. The bothria are very indistinct, elongated, narrow, parallel, giving to the larva a striated appearance. Dimensions of one alcoholic specimen: Length, 6 mm.; diameter, 1.25; length of proboscis, approximate, 0.56; length of proboscis sheath, about 1; diameter of proboscis at base, exclusive of hooks, 0.08; at apex, 0.07. In one of the lots from the swordfish three of the larval *T. bicolor* were found with their proboscides penetrating the tissues of *Rhynchobothrium attenuatus*, with which they were associated.

Length of living specimen from *Xiphias gladius*, 10.5; neck inclosing short tail-like part by a collar; color of living specimen, yellowish white. The specimen from the dusky shark was purple red, adhering to pyloric division of stomach. The stomach wall was locally inflamed where this parasite was attached. There was also another ulcerated spot in the mucous membrane near by.

In life the greater part of the specimen was a deep purple red. The anterior end and the posterior behind the bothria were a few shades lighter.

¹Diesing, Revis. d. ceph. ab. Par., p. 316.

The specimen was quite active when first removed: Length, 7 mm.; diameter in front, 2; diameter middle, 2.5; diameter posterior end, 1.5; diameter of posterior appendage, beginning of strobile, 0.5.

In the alcoholic specimen a little more than the middle third was dark brown, the two ends were yellowish white. Length of proboscis, 1 mm.; diameter of proboscis, exclusive of hooks, at base, 0.11; apex, 0.05; length of contractile bulbs, 1; length of longest hooks, 0.03. For character of hooks see figs. 5, 6.

I have no color notes on the specimens from the tiger shark, and infer that they were the usual yellowish white of most entozoa. The arrangement and character of the hooks agree with those figured for specimens from dusky shark. Dimensions of alcoholic specimen: Length, 5 mm.; maximum diameter, 1.4; length of proboscis, 1; diameter at base, 0.10; near middle, 0.08, including hooks; length of ordinary hooks, 0.026.

18. SYNBOOTHRIUM FILICOLLE, Linton.

(Plate VIII, figs. 7-12.)

Syndesmobothrium filicolle, LINTON, U. S. Fish Com. Rept., 1887, pp. 861-862, pl. xv, figs. 2-4.

Tetrahynchobothrium (larva), Amer. Nat., Feb., 1887, p. 199, pl. x, figs. 7-11.

Synbothrium scoler, HILL, Proc. Linn. Soci. New South Wales (1891), IX, pp. 75-82, pl. v, figs. 14-19.

I have found this parasite in its larval condition—i. e., embryo and blastocyst encysted—frequently and in a variety of hosts, the most usual host being the bluefish (*Pomatomus saltatrix*).

Following is a list of hosts in which I have found this worm. The list also comprises most of the finds of the parasite that I have made; all collections except No. 9 made in the vicinity of Woods Holl, Massachusetts:

Synbothrium filicolle.

No.	U.S.N.M. number.	Date.	Host.
1	5495	Aug. —, 1884	Bluefish (<i>Pomatomus saltatrix</i>), serous covering of stomach, etc.
2	4824	.....do	Squeteague (<i>Cynoscion regalis</i>), outside of ovary.
3	.....	.....do	Squeteague (<i>Cynoscion regalis</i>), serous covering of viscera.
4	4809	.....do	Bluefish (<i>Pomatomus saltatrix</i>), on stomach and intestine.
5	.....	.....do	Bluefish (<i>Pomatomus saltatrix</i>), on viscera.
6	4831	July 24, 1886	Dogfish (<i>Mustelus canis</i>), muscular coat of stomach.
7	5490	Aug. 5, 1886	Bluefish (<i>Pomatomus saltatrix</i>), serous covering of viscera.
8	5486	Aug. 12, 1886	Cero (<i>Scomberomorus regalis</i>), on stomach, liver, etc.
9	5485	Oct. —, 1886	Bluefish (<i>Pomatomus saltatrix</i>), mesentery, etc., collected by S. E. Meek, Fulton Market, New York.
10	5992	July 27, 1887	<i>Pomolobus medicris</i> , serous covering of viscera.
11	5496	July 29, 1887	Bluefish (<i>Pomatomus saltatrix</i>), serous covering of viscera, and between mucous and submucous coats of stomach.
12	5491	July 30, 1887	Cero (<i>Scomberomorus regalis</i>), on viscera.
13	5493	Aug. 1, 1887	Sting Ray (<i>Trygon centrura</i>), stomach wall.
14	5489	Aug. 6, 1887	<i>Lobotes surinamensis</i> , serous covering of viscera.
15	.....	Aug. 8, 1887	Dogfish (<i>Mustelus canis</i>), stomach wall.
16	4810	Aug. 10, 1887	<i>Trygon centrura</i> , stomach wall and spleen.
17	4813	Sept. 2, 1887	Common Flounder (<i>Paralichthys dentatus</i>), stomach wall.
18	.....	July 9, 1889	Bluefish (<i>Pomatomus saltatrix</i>), serous covering of viscera.
19	.....	July 15, 1889	Bluefish (<i>Pomatomus saltatrix</i>), on liver, spleen, etc.
20	5488	July 27, 1889	Bluefish (<i>Pomatomus saltatrix</i>), serous covering of viscera.
21	4792	July 29, 1889	Caballe (<i>Scomberomorus cavalla</i>), serous covering of viscera.
22	.....	Aug. 19, 1889	Cero (<i>Scomberomorus regalis</i>), serous covering of viscera.
23	5487	Aug. 20, 1889	<i>Scomberomorus maculatus</i> , serous covering of viscera.
25	4808	....., 1883	Squeteague (<i>Cynoscion regalis</i>), on viscera (No. 898 U.S.N.M.), collected by R. S. Tarr.

In No. 11 of the above list thirteen specimens of bluefish were examined. In Nos. 18, 19, 20, and 23 there were forty-four fish examined. Cysts containing larval Tetrarhynchidae are rarely absent from the bluefish.

The hooks as represented in figs. 9, 10 are quite different from those heretofore published for this species. The specimen described in the United States Fish Commission Report for 1889 had the proboscides retracted so that only a few hooks lying near the base of a proboscis could be distinctly seen. The most distinctive feature of the proboscides of this species is the relatively long, slender, and nearly straight hooks, which are the predominating kind, and in certain parts of the proboscis the only kind. Most of the long slender hooks, when seen under favorable conditions, with proper enlargement, are seen to be notched at the end, a feature which is characteristic of this worm. This feature is easily overlooked, and I have repeatedly thought I had found embryos which did not possess it, but upon a careful examination of an everted proboscis, I have never failed to find hooks with their extremities notched.

I reproduce here, with some slight alteration, my account of this worm given in an article published in the "American Naturalist."¹

Another form of cyst I will notice briefly and illustrate by an embryo taken from the surface of the liver of the eero (*Scomberomorus regalis*). This cyst is long and slender, about 10.5 mm. in length and 1.5 in diameter, yellowish, opaque, but broken in places so as to show the outline of the blastocyst.

The blastocyst, which is set free when the walls of the cyst are ruptured, is long and slender, with a neck-like constriction at one end. The head part thus set off is very changeable in form, expanding, contracting, moving up and down and from side to side, and rotating on the constricted neck. The longer part or body of the blastocyst also undergoes much change of form by irregular contraction and expansion, but these movements take place more slowly than in the head. The color is ivory white, slightly translucent when extended. When compressed, the embryo is discovered lying in a coil in the head of the blastocyst. The parenchyma of the head part is now seen to be much coarser than that of the body part, the coarseness being due to the presence of numbers of large, oval, refractile fluid spaces. The parenchyma of the body is dense and finely granular, with smaller retractile masses than those in the head part. When the head part of the blastocyst is broken open, the embryo is released, but instead of separating from the blastocyst, as in the case of an embryo *Rhynchobothrium*, the blastocyst remains attached to the scolex much like the cystocercus of *Tania*. The method of release, however, is quite different from that of the cystocercus of most *Tania*. Instead of unfolding like the finger of a glove, the neck of the scolex first emerges in the

¹ February, 1887.

form of a loop. While in this position the head lies close beside the base of the neck in the vicinity of the contractile bulbs. The head is released by a simple straightening of the neck, which, at its base, a short distance back of the contractile bulbs, remains attached to the head part of the blastocyst. In this specimen, after the head of the scolex was released, the anterior part or head of the blastocyst continued for some time working backward and forward on the neck of the scolex like a movable barrel on a stationary piston. Considerable pressure was applied for the purpose of making the scolex separate entirely from the blastocyst, but without causing it to break loose. When pressed out as far as it would go, it could be seen that there was an unbroken continuity between the scolex and the blastocyst. The posterior tapering end of the scolex, however, was clothed with straight, fine, hair-like bristles like those noticed in an embryo *Rhynchobothrium*.

The bothria are four in number, in opposite, lateral pairs, spreading from the front of the head. They are quite mobile, sometimes with the sucking disks turned forward, sometimes backward, and with a retractile proboscis, armed with long, slender, slightly recurved hooks, belonging to each bothrium. The proboscides were everted but a short distance, but they were apparently fully developed. The proboscis sheaths are spiral and the contractile bulbs slender. A reticulated system of vessels in the margins of the bothria and sinuous longitudinal vessels behind the contractile bulbs and near the edges of the blastocyst were made out in the living specimen.

In a specimen which was lightly stained with carmine and placed in glycerine, the scolex and body part of the blastocyst are red, while the globular head-like part of the blastocyst is golden yellow, the staining fluid only showing faintly in some longitudinal central vessels. This same part in unstained specimens in alcohol is yellowish and more opaque than the body, which is white with a faint bluish tinge.

The development of this form at this period differs from that of *Rhynchobothrium*, in that the blastocyst is retained as a part of the scolex after the latter is released. I have repeatedly tried the experiment of opening blastocysts of these two types, with the results in every case the same. In the one case the embryo does not seem to have any permanent connection with the blastocyst when the walls of the latter are broken; in the other, the embryo can not be removed from the blastocyst without breaking a connecting bond. The finding of a specimen¹ in the intestine of a sting ray (*Trygon centrura*) proves that the blastocyst maintains its connection with the embryo for some time and through many vicissitudes. It is highly probable that it thus forms a part of the adult strobile, or at least remains attached as a nutritive vessel until absorbed by the growing strobile.

Following are brief excerpts from memoranda made on some of the

¹ United States Fish Commission Report, 1897, p. 861, pl. xv, fig. 2.

foregoing lots, either at time of collecting or in the subsequent examinations of them incident to the work of identification. These notes I shall arrange under the head of the several hosts:

1. *Pomatomus saltatrix*.—Cysts containing this parasite are of frequent occurrence in this host. They usually occur in elongated cysts lying on the viscera, in the mesentery, sometimes embedded in the liver. I find among my notes mention of one which had the exceptional position of being under the submucous coat of the stomach. The length of this blastocyst was 25 mm. It was rolled up irregularly into a round mass.

Usually these cysts can be readily recognized from those containing *Rhynchobothrium* larva by their more slender habit, and, where the outline of the contained blastocyst can be distinguished, by the neck-like constriction near one end which separates the subglobose head portion, in which the embryo lies, from the elongated body of the blastocyst. The blastocyst is sometimes very long and does not seem to bear any special relation to the size of the embryo, which, when fully developed, does not exhibit much variation in size. The longest cyst from the bluefish of which I have made measurements is 55 mm.; anterior part, 3 in diameter, elongating to 6; posterior part, 1.1 in diameter. After twenty-four hours in water one of these blastocysts measured 92 mm. in length. In one lot of cysts examined in alcohol, among the usual elongated forms was one oval cyst, which contained a dark brown mass of waxy consistency, in which a blastocyst of a *synbothrium* was found. The posterior part of the blastocyst, instead of being elongated, was contracted to 5 mm. in length, and was 2.25 mm. in breadth.

2. *Cynoscion regalis*.—I have not found this parasite of frequent occurrence in the squeteagone. When they do occur, they have the same appearance as those of the bluefish. Dimensions of alcoholic specimen: Length of blastocyst, 27 mm.; length of anterior portion, 6; diameter of anterior portion, 2.5; diameter of elongated posterior portion, 2; length of embryo, approximate, 4.6; breadth of head (compressed), 0.48; diameter of neck, 0.17; length of contractile bulbs, 1.4; length of slender hooks on proboscis, 0.06 to 0.08. Color of head portion yellowish brown, elsewhere whitish.

3. *Scomberomorus cavalla*, *S. regalis*, *S. maculatus*.—This parasite appears to be of frequent occurrence in these fish. I have not had the opportunity of examining many of these fish, but all that I have examined have had a number of these parasites in elongated cysts on the viscera. One specimen from *S. maculatus* was found with a mass of carbonate of lime in the posterior part of the blastocyst.

4. *Pomolobus mediocris*.—A blastocyst, with everted embryo attached, from the peritoneum of this fish, was very active when first removed from the yellowish-white cyst, varying in length within short intervals from 9 to 20 mm. The globular anterior portion from which the head

and neck of the embryo were released was the most changeable, its walls being well supplied with contractile tissue.

Dimensions of alcoholic specimen: Length of posterior elongated portion, 7.1 mm.; diameter of same, 0.9; diameter of globular anterior portion, 1.5; breadth of head of embryo, 0.47; diameter of neck, 0.2; length of longest hooks, 0.08; length of small hooks, 0.013.

5. *Paralichthys dentatus*.—The single specimen which I have from this host presents some differences from those from other hosts and may differ from them specifically. A sketch was made of the living specimen, but no other notes made at time of collecting. The sketch shows the usual division of the elongated blastocyst into an anterior subglobular portion containing the embryo and an elongated posterior portion—the latter about three and a half times the length of the former when at rest. When compressed, there is brought into view an interior prolongation of the posterior part, which extends into the anterior portion, occupying about the posterior fourth of that part, while the embryo is confined to the anterior fourth of the same part. Two prominent sinuous vessels are seen in the anterior part lying one on each of the lateral margins—when compressed (fig. 8). Unfortunately the alcohol had evaporated from this specimen when I came to study it for identification, and it was in very poor condition. The hooks were dark red. This I think must be due to changes with the drying of the specimen, since I find no mention of such fact among my notes. If the hooks had been red in the living worm, that fact would hardly have been overlooked, although but superficial examination was made of it at that time. The breadth of the head, alcoholic, is 0.46 m.; diameter of neck, 0.12. The largest hooks are not well shown; length of such hooks as were seen, near base of proboscis, 0.038. This is much less than length of characteristic long slender hooks in this species, but not contradictory of that species, since some hooks near base of proboscis in typical specimens may be found having such dimensions as this.

6. *Trygon centrura*.—Found on three occasions in this host, where its presence must be regarded as accidental (*Xenosite*, van Beneden). One examined as alcoholic specimen; proboscides fully extended and exhibiting characteristic hooks; at base hooks resemble those figured in my paper in the United States Fish Commission report for 1887; elsewhere hooks long and slender, about 0.06 mm. in length; standing nearly at right angles to the proboscis, and having the appearance of being in whorls instead of spirals, with about ten hooks in a whorl.

The cysts from one sting ray were hard, with a yellowish-white granular deposit, appearing to be undergoing degeneration, but with larvæ developed in them.

7. *Mustelus canis*.—Found at two different times in this host. Specimens identical with those found in sting ray, large hooks slightly bifurcate; this character also seen in hooks of specimens from other hosts. Measurements of living specimen: Length of cyst, 5 mm.; diameter, 3;

length of blastocyst, about 20; breadth of head of embryo, 0.72; diameter of neck, 0.2; length of bulbs, 0.9; length of hooks, 0.06. The anterior portion of blastocyst was oval, with about three constrictions posteriorly, giving it a somewhat chrysalis outline. The length of the head and neck of embryo in one instance, 4.5 mm.; in another, 5.2.

Hill¹ has examined some of the developmental stages of a *Synbothrium* agreeing closely with published descriptions of *S. fillicolle*, which he finds in the peritoneum surrounding the intestine of the jewfish (*Seiuna aquila*).

The following conclusions are reached by that author:

1. The so-called blastocyst or endocyst is the serial homologue of the caudal vesicle of the *Cysticerci*.
2. The wall of the invagination sac represents the body of these forms.
3. The scolex, consisting of head and neck, arises from the bottom of the invagination sac, as a knob-shaped process, which, by subsequent elongation and differentiation, gives rise to the fully formed scolex.

EXPLANATION OF PLATES.

Many of the figures were drawn with the aid of an Abbe camera lucida, mounted on a Zeiss stand No. VII.

Where not expressly stated otherwise, it is to be understood that the sketches are made from alcoholic specimens.

Plate V, figs. 8-11, were drawn by Mrs. M. B. Linton, other figures by the author.

PLATE I.

Ligula chilomycteri, from spleen of *Chilomycterus geometricus*.

1. Anterior end of specimen. Enlarged three times.

Larval dibothrium (?) from cyst in *Sarda sarda*.

2. Entire specimen. Enlarged eighteen times.

3. Posterior end of same, cleared in oil of cloves, enlarged about fifty times.

Larval *Echeneibothria*. ?

4. Scolex of specimen from intestine of *Limanda ferruginea*. Enlarged two hundred and twenty-five times.

5. Specimen from intestine of *Lophius piscatorius*, showing pseudosegment, life. Enlarged twelve times.

6. Specimen with head retracted from gall bladder of *Cynoscion regalis*, life. Enlarged sixty times.

7. Specimen from same host, myzorhynchus funnel-shaped, life. Enlarged sixty times.

8. Specimen from gall bladder of *C. regalis*, red spots, life. Enlarged thirty-six times.

9. Scolex from same host, head retracted, life.

10. Scolex from same host, myzorhynchus extended, life.

11. Abnormal specimen from gall bladder of *C. regalis*, life. Enlarged twelve times.

12. Specimen from gall bladder of *C. regalis*, compressed, life. Enlarged twenty-four times.

¹ Proceedings of the Linnean Society of New South Wales, IX, p. 75.

13. Anterior end of head of same, compressed, life. Enlarged two hundred and twenty-five times. *b b*, bothria; *p. myzorhynchus*; *v, v*, vessels of water vascular system; *c*, calcareous bodies.

14. Specimen from intestine of *Paralichthys dentatus*, contracted, life.

15. Abnormal specimen from same host; *a*, posterior end contracted, life.

PLATE II.

Phyllobothrium loliginis, from the squid (*Ommastrephes illecebrosus*)

1. Specimen slightly compressed and enlarged, life.
2. Sketch of specimen lying in water, life.
3. Scolex with one bothrium flattened on bottom of dish, life.
4. Scolex compressed and magnified. *p. myzorhynchus*: *b b*, bothria; *v*, vessel of water vascular system, life.
5. Single bothrium, enlarged, life.
6. Anterior end of bothrium, showing auxiliary suckers, life.
7. Very young scolex, magnified, life.
8. Another young scolex, showing different state of contraction, life.
9. Another young scolex with bothria retracted; *b*, posterior edge of bothrium, natural size.

Thysanoccephalum, species from the squid (*Ommastrephes illecebrosus*).

10. Lateral view of scolex. Enlarged two hundred and twenty-five times.
11. Antero-marginal view of same. Enlarged two hundred and twenty-five times.

Rhynchobothrium larva.

12. Part of proboscis and hooks of specimen from cyst in *Centropristes striatus*; *a b*, hooks from opposite sides of proboscis near apex. Enlarged three hundred times.
13. Cyst (*c*) with blastocyst (*b*) and embryo (*e*) from *Caranx chrysus*. Enlarged eighteen times.
14. Embryo of same released from blastocyst and enlarged.
15. Portion of proboscis of same, highly magnified.
16. Cyst (*c*), blastocyst (*b*), and embryo (*e*) from *Anguilla chrysypa*; *m*, hyaline membrane surrounding the blastocyst. Enlarged fifteen times.

PLATE III.

Rhynchobothrium larva.

1. Embryo removed from cyst, peritoneum of *Anguilla chrysypa*. Enlarged fifteen times, life.
2. Cyst, blastocyst, and embryo from *Microgadus tomcod*. Enlarged fifteen times, life.
3. Cyst, blastocyst, and embryo from *Prionotus erolans*. Enlarged twenty times, life.
4. Embryo removed from cyst (fig. 3). Enlarged twenty-four times, life.
5. Ten hooks from proboscis of embryo (fig. 4). Enlarged three hundred and seventy-five times.
6. Hooks, base of proboscis of embryo from cyst in *Menticirrhus saxatilis*. Enlarged two hundred times.
7. Hooks, base of retracted proboscis of embryo from cyst in *Macrurus bairdii*. Enlarged two hundred times.
8. *a* to *f*, hooks, proboscis of embryo from cyst in *Phycis chuss*. Enlarged three hundred times.
9. Two hooks from proboscis of embryo from cyst in *Stenotomus chrysops*. Enlarged about three hundred times.

10. Cyst with blastocyst and embryo from *Stenotomus chrysops*. Enlarged twenty-two times, life.
11. Embryo removed from cyst (fig. 10). Enlarged, life.
12. *a* and *b*, parts of proboscis of same (fig. 11), showing retractor muscles (*r m*) and granular ribbon (*g*) through the transparent walls. Enlarged two hundred and twenty-five times, life.
13. Optical section of contractile bulb of embryo shown in fig. 11, showing insertion (*m*) of retractor muscle of proboscis, life.
14. *Rhynchobothrium* from intestine of *Carcharias littoralis*. Enlarged ten times.
15. Part of body of same showing racemose bodies. Enlarged two hundred and twenty-five times.
16. Hooks from retracted proboscis of same, large hook near base, small hook near middle or toward apex of proboscis. Enlarged three hundred times.
17. Embryo from cyst in *Pomatomus saltatrix*. Enlarged three times.
18. Lateral view of head of same. Enlarged twenty-seven times.
19. Hooks from retracted proboscis of same. Enlarged three hundred times.

PLATE IV.

Rhynchobothrium larvæ.

1. Cyst with blastocyst and embryo from *Cynoscion regalis*. Enlarged eighteen times, life.
2. Blastocyst from *Mustelus canis*. Enlarged three times.

Rhynchobothrium heterospine, Linton, from *Anguilla chrysypa*.

3. Blastocyst (*b*) inclosed in a hyaline envelope (*h*) and containing an embryo (*e*). Enlarged, life.
4. Embryo removed from blastocyst (fig. 3). Enlarged twenty-two times, life.
5. Contractile bulb and beginning of proboscis sheath, diagrammatic representation of diagonal muscles, life. From embryo (fig. 4).
6. Optical section of same: *a*, proboscis sheath; *b*, wall of bulb; *c*, central cavity filled with fluid which is forced out into the proboscis sheath by the contraction of the muscular walls of the bulb, thus causing the proboscis to unroll; *d*, retractor muscle inserted on the wall of the bulb and attached to the tip of the proboscis. The contraction of the longitudinal fibers of this muscle retracts the proboscis, life.
7. Anterior end of bulb, optical section, more enlarged, letters same as in fig. 6.
8. Hooks from proboscis of embryo (fig. 4). Enlarged three hundred times.

Rhynchobothrium imparispine, Linton, from *Lophius piscatorius*.

9. Cyst. Enlarged about three times, life.
10. Blastocyst from same, compressed to show embryo. Enlarged nine times, life.
11. Embryo with blastocyst attached as nutrient vessel. Enlarged six times, life.
12. Hooks from proboscis of same. Enlarged three hundred and forty times.

Rhynchobothrium speciosum, new species.

13. Embryo removed from cyst, peritoneum of *Pomatomus saltatrix*. Enlarged three times. *a*, bothrium. Enlarged six times.
14. Optical section of neck of living specimen from *P. saltatrix*. Enlarged eighteen times. *c*, cuticle; *gl.*, granulo-fibrous layer; *rl.*, vascular layer; *lm.*, longitudinal muscles; *Pm.*, parenchyma; *sh.*, proboscis sheath; *rm.*, retractor muscles of proboscis; *Pr.*, retracted proboscis.